3D macroporous silicon photonic crystals with large complete photonic bandgap

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Recently a new 3D photonic crystal structure consisting of two triangular pore sets, which intersect each other orthogonally, was proposed. The structure has orthorhombic symmetry and its Brillouin zone resembles a slightly strechted fcc-zone. For optimized structure parameters and silicon as a matrix material a complete photonic bandgap of 25% is predicted.

We demonstrate the experimental realization of this structure applying a two step process. A photoelectrochemical etch process creates the first triangular set of macropores with high aspect ratios in silicon. Subsequently a focused ion beam is used to drill the second pore set from the side. The lattice constant of the triangular pore sets is 500nm and the pore diameter around 380nm. Reflection measurements along different crystallographic directions reveal the spectral position of the bandgap in the near infrared around a wavelength of 1.3 micrometers [1]. The influence of experimental errors (e.g. shift, tilt and rotation of the two pore sets) on the size of the bandgap are studied by bandstructure calculations. From this the fabrication tolerances are concluded to assure structures with bandgaps above 10%.

[1] J.Schilling, A. Scherer, G. Stupian, R. Hillebrand, U. Gösele, *Applied Physics Letters* **86**, 011101 (2005).